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DESIGN AND IMPACT OF AWARENESS FUNCTIONS - A STUDY ABOUT SOCIAL MEDIA IN VIRTUAL TEAMS

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Abstract

The usage of social media in leisure time settings has become a prominent research topic. However, less research has been done on the design of social media in collaboration settings. In this study, we investigate how social media can support asynchronous collaboration in virtual teams and specifically how they can increase activity awareness. On the basis of an open source social networking platform, we present two prototype designs: a standard platform with basic support for information processing, communication and process – as suggested by Zigurs and Buckland (1998) – and an advanced platform with additional support for activity awareness via special feed functions. We argue that the standard platform already conveys activity awareness to a certain extent, however, that this awareness can be increased even more by the feeds in the advanced platform. Both prototypes are tested in a field experiment and evaluated with respect to their impact on perceived activity awareness, coordination and satisfaction. We show that the advanced design increases coordination and satisfaction through increased perceived activity awareness.

Keywords: awareness, virtual teams, social media, social networking sites, feeds, microblogging, asynchronous media

1 Introduction

Social media have conquered our lives and are – especially in younger generations – shaping many of our interactions with others today. When we think of social media, we see in the first place the advantages for our private lives. In particular, social networking platforms (SNPs) like Facebook are increasingly used for communicating and staying connected with friends and family. In this paper, we deploy social networking functions in a rather unorthodox way. Unlike using them for the usual purpose of building and maintaining relationships in leisure time communities, we redesign a social networking platform for enhancing awareness in virtual teams.

Virtual teams often struggle with the problem of reduced awareness about others' activities and thoughts (Cramton, 2001; Ocker, Hiltz, Turoff and Fjermestad, 1995). This is because virtual teams predominantly, if not even exclusively, rely on media that is not capable of conveying such contextual cues. Research on awareness has generated various designs for supporting awareness and has found positive effects of computer-mediated awareness on coordination of communication, willingness to work and decision effectiveness (Cooper and Haines, 2008; Dabbish and Kraut, 2008; Haines, Vehring and Kramer, 2011). The designs have predominantly focused on improving the awareness about immediate activities or availability (e.g. who is talking? who is in the workspace? who is ready?) and have been evaluated with teams working on structured tasks that were limited to a few hours. However, teams in nowadays organizations are mainly formed for working on unstructured or fuzzy tasks (e.g. planning a new product or writing a new business case) which usually require more time (e.g. a few weeks). In these settings, the team task is often split in subtasks which are distributed among the members of the team. For coordinating the interdependencies between the subtasks individuals need awareness about rather general activities (e.g. who is working on what task? how much progress has been made?) than immediate activities. Our research therefore investigates the design and impact of awareness functions in teams working on unstructured tasks that require collaboration over several weeks.

By integrating social networking and online word-processor functionality, we design a collaboration platform that supports virtual teams with basic functions for communication, information processing and process support (Zigurs and Buckland, 1998). We show how these functions already support awareness to a certain extent. However, beyond these three functional groups for conventional collaboration support we argue that a fourth group of special awareness functions can significantly enhance awareness and collaboration in virtual teams. For comparing these designs, we test both platforms with triads working on a fuzzy task over a period of five weeks. In particular, we demonstrate that an advanced platform with special awareness support will increase coordination and satisfaction in teams through increased perceived awareness.

2 Literature Review

2.1 Social Networking Platforms

An SNP can be defined in terms of its core functions as an online platform that enables individuals to create a public or semi-public profile, articulate a list of other users with whom they share a connection (so-called "friend list"), and browse their list of connections and those made by others (Boyd and Ellison, 2007). Next to these core functions which define SNPs, modern SNPs such as Facebook or Yammer have evolved to complex websites with a myriad of add-on functions (e.g. feeds, groups, chat etc.). An add-on function with growing importance in SNPs are the so-called news feeds, which are little messages informing about other users' interaction with other SNP-functions (e.g. changes to profiles, adding new friends, joining groups, writing status updates). Typically, feeds can only be seen by other connected users (so-called "friends"), which can click on the feeds to request more information about the user or the specific activity of that user. Although, concerns of information overload were reported, e.g. in the case of Facebook, feeds have become an effective tool for keeping in touch with the many online contacts of a typical Facebook user and have been found to account for 27% of all user clicks (Constine, 2011).

While some companies have adopted SNPs in their organizations with the aim of enhancing relationship building and informal knowledge sharing among dyads (Riemer, Diederich, Richter and Scifleet, 2011), there is scant research on how SNPs can support team collaboration. The few studies on SNPs in collaboration settings are mostly concerned with knowledge sharing among members in a large community rather than in teams (Riemer et al., 2011). However, it still remains unclear whether social media functions really improve collaboration and how these functions should be designed to fit to the context of team-based collaboration.

2.2 Virtual Teams

Virtual teams are usually defined as geographically-distributed individuals that use information technologies for accomplishing their work (Powell, Piccoli and Ives, 2004). Consistent with the increasing global internetworking of economies and organizations, the advantages of virtual teams are predominantly seen in working across temporal boundaries, sharing knowledge across locations and generating new product designs (e.g in multinational companies) as well as reducing operating costs and increasing work efficiency (e.g. nearshoring and offshoring) (Cramton, 2001). However, the usage of information technology alters important team processes such as the formation of trust and cohesion, consensus finding, relationship building, communication and knowledge sharing as well as coordination (Powell et al., 2004). In particular, virtual teams struggle to effectively share information as well as to efficiently coordinate their work (Cramton, 2001).

The underlying problem for reduced knowledge sharing and coordination capabilities is often seen as a lack of shared understanding in virtual teams (Cramton, 2001). In contrast to collocated teams, virtual teams do not have the possibilities to communicate informally (Kraut, Fussell, Brennan and Siegel, 2002) and lack reference points for coordinating their work flows (Ocker et al., 1995). In general, there is a lack of contextual cues informing individuals about what other team members are doing, thinking or feeling (Cramton, 2001; Ocker et al., 1995). Virtual team literature suggests that this problem can be alleviated by faithful appropriating to the offered information technology, teaching of information technology capabilities, meeting up-front and during the virtual team work and following prescribed team processes (DeSanctis and Poole, 1994; Kiesler and Cummings, 2002; Massey, Montoya-Weiss and Yu-Ting, 2003; Nardi and Whittaker, 2002) While there has been some research on the support of same time / different place (synchronous) collaboration little has been studied about how capabilities of information technology itself can convey more contextual cues and eventually improve different time / different place (asynchronous) collaboration in teams (Massey et al., 2003).

3 Prototypes and Evaluation Framework

3.1 Standard Platform with Basic Collaboration Functions

Collaboration support for teams should match the characteristics of the team task (Zigurs and Buckland, 1998). Most virtual teams are project teams that carry out fuzzy tasks. Fuzzy tasks are tasks with little focus, which require team members to spend a lot of time understanding and structuring the problem and are characterized by information diversity, information load, conflict and uncertainty (e.g. planning a production facility for a new product) (Campbell, 1988). The high complexity requires members to exchange and process information on a high level. Fuzzy tasks thus require strong communication as well as information processing support (Zigurs and Buckland, 1998). Moreover, fuzzy tasks allow for multiple possible solution schemes and solution paths which make it difficult to plan the process ex ante. Since the process the group undergoes is subject to creative problem solving, the medium should not predetermine the process structure. Consequently, the process support should be low to medium (Zigurs and Buckland, 1998).

According to these guidelines we created an SNP based on the open source platform Elgg. The prototype with the basic collaboration support is constituted of profiles, forums, direct messaging and conjoint word processing (see Figure 1). These artifacts support communication, information processing and process in the following way:

Communication Support– As mentioned earlier, we focused on the asynchronous support of communication, namely through forums and direct messages. Forums were implemented as simple web discussion boards, where all team members could write discussion comments visible to all team members –hence enforcing one-to-many communication. Direct messages would work similar to email. Every team member had a message box where she could send and receive messages from one or more members of the team –thus supporting one-to-many as well as one-to-one communication. Every time a discussion post was made in the forum or a message was received, the system sent a notification email to the team member's account. Thus, these functions allowed for simultaneous input, one-to-one and one-to-many communication

Information Processing Support – Zigurs and Buckland (1998) deem information processing support as high if functions help to gather, aggregate, structure and evaluate information. For this reason we integrated the online word processor GoogleDocs into the platform. GoogleDocs allows simultaneous collaboration on a focal artifact and provides full word processing functionality such as capabilities for formatting, structuring and commenting on texts as well as inserting pictures and tables. Moreover, GoogleDocs allows to view and comment on PDF-documents. Document material needed for accomplishing the task can be made available in the system and text sections can be – similar to the comment function in ordinary word processors– commented directly in the documents.

Process Support – As process support should be medium and should not interfere with the way a group structures its coordination or solution path, we limited process support to offering a record of group interactions in the form of a structured overview on direct messages and forum posts (Zigurs and Buckland, 1998).

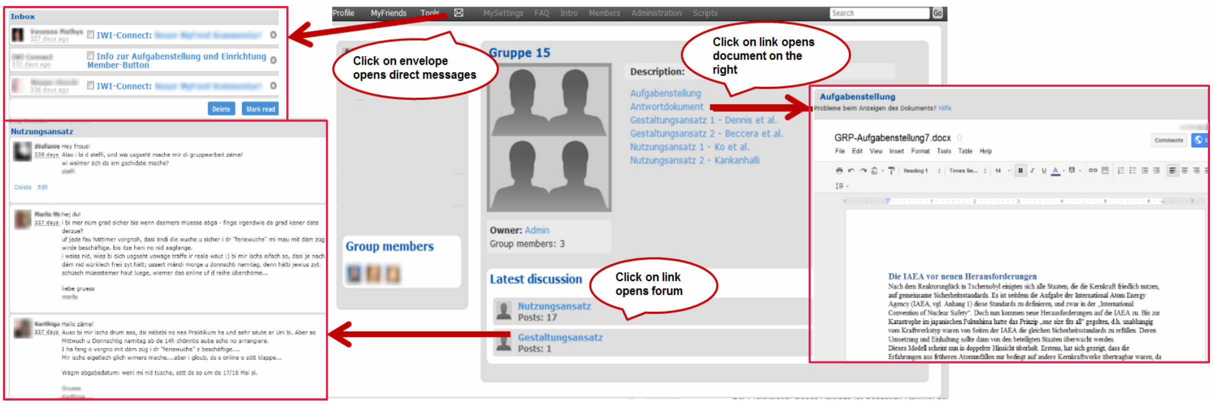

Figure 1: Standard platform: team view with links to documents, direct messages and forums

Furthermore, we kept the profile function used in Elgg. Profiles included a function for uploading a profile photo and profile fields, where team members could fill in their task domain, prior experiences and hobbies. Profile photos would also appear with every forum post and direct message.

3.2 Advanced Platform with Additional Awareness Support

We define awareness as an individual's perception of her/his team members' activities derived from cues delivered by the used information technology (Adapted from Dabbish and Kraut, 2008; Endsley, 1995). Awareness is important in mixed-focus collaboration, where people shift frequently between individual and group activities during a team work (Dourish and Bellotti, 1992). In a group environment awareness can be conveyed through different awareness communication mechanisms: feedthrough communication (team members can see changes in the team's shared artifacts) (Dix, 2004), intentional communication (team members can communicate awareness through messages to others) (Heath and Luff, 1992), and consequential communication (team members can see the interactions of others with the virtual environment) (Segal, 1994). Table 1 illustrates how the functions of the basic prototype already support awareness: Google Docs provide awareness on how the team artifacts are evolving and thus show what is being done by the team (feedthrough), team members can directly communicate information on their present work activities via direct messages and forum posts (intentional communication) and they can read the history of past direct messages and forum posts to understand their past work activities (intentional communication). However, basic functions for communication, information processing and process support do not provide consequential communication of awareness. We therefore propose a new category of functions for special awareness support, which complements the other three function categories by adding additional mechanisms for intentional communication of awareness and in particular consequential communication of awareness.

Platform Differences ►	**←-------------------Functionality of the advanced platform-----------------------→**			
	←---------Functionality of the standard platform--------→			
Awareness communication mechnisms ▼	**Information Processing Support**	**Communication Support**	**Process Support**	**Special Awareness Support**
Feedthrough	Google Docs	-		-
Intentional Communication	-	Direct Messages, Forum Posts	History of direct messages and forum posts	Status updates, comments on status updates
Consequential Communication	-	-	-	Automatically generated feeds

Table 1: Functional differences between the standard platform and the advanced platform

Awareness Support – The additional awareness functions are all based on the feed function earlier discussed within the context of SNPs. The mechanisms for intentional communication of awareness that are added in the advanced prototype are hand-written feeds such as status-updates and comments on status-updates. Status-updates are a very informal communication instrument and specifically hand-written status updates give team members the possibility to give timely updates on their activities or express their current state of mind. Workers are reported to write status updates for giving insight into their current tasks, task progress, availability, intentions and work rhythms (Meyer and Dibbern, 2010; Riemer et al., 2011).

The mechanisms for consequential communication of awareness are automatically generated feeds about a user's interaction with the workspace. These are little messages that report whether another team member wrote a group forum post, changed a document or altered her profile. This function thus explicitly tracks a team member's interaction with other communication functions in the system.

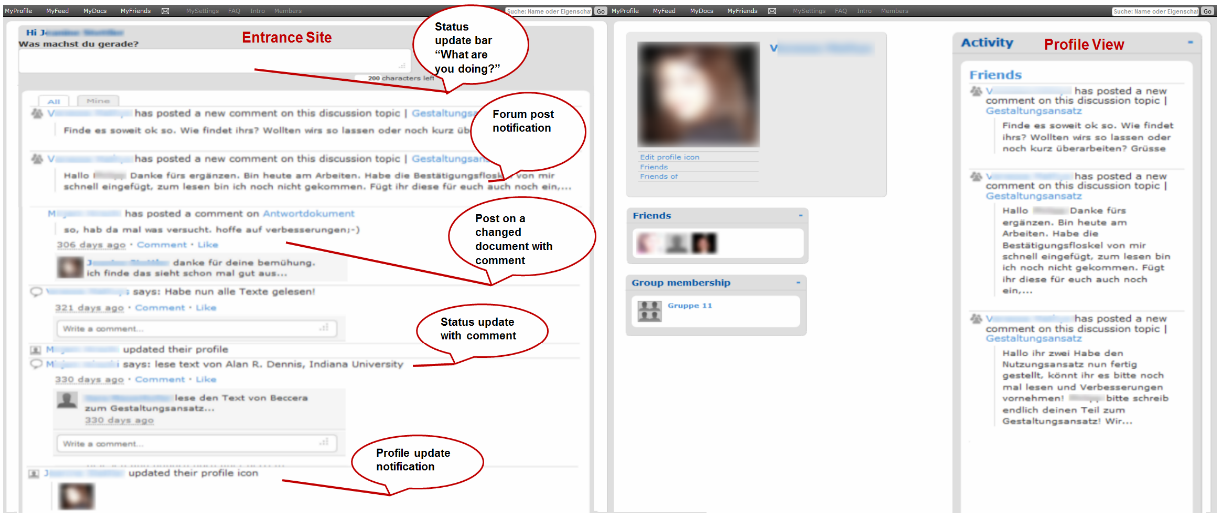

Figure 2: Additional functions of the awareness-enhanced platform: Time line of group feeds (left) and profile feeds (right)

The automatically generated messages as well as the status updates could be seen in two different feed views. The group time line of feeds showed all past messages from all team members. The feed time line on each user’s profile showed all feeds pertaining to the owner of the profile. In that way team members had awareness about what was happening in the team as well as a filtered awareness view about each individual team member. Next to these views, which support pulling awareness, status updates, comments on status updates and comments on documents were sent as an email to all team members.

*H1: Compared to the basic platform with functions for information processing, communication and process support **only**, the advanced platform with functions for information processing, communication, process **and additional awareness support** increases activity awareness.*

3.3 Coordination and coordination quality

Coordination in virtual teams can be defined as the act of managing interdependent work activities among team members (Wang, Kleinman and Luh, 2001). Consequently, we define coordination quality as a team’s ability to coordinate tasks among its members (Lewis, 2003). Van de Ven (1976) distinguishes between two forms of coordination: impersonal coordination via plans, rules or standards and personal coordination via mutual adjustment between individuals. Activity awareness can improve in particular personal coordination via mutual adjustment. Knowing about the others momentary activities can improve every person’s own adjustment with one or more people in the team as well as leading the whole team. Given two individuals, whose tasks are interdependent, both individuals benefit from knowing what the other is doing (e.g. whether that person has finished the task or not) in the way that they can adjust their activities to that situation (e.g. start with their task or wait for the results of the other). Furthermore, misunderstandings can be avoided by knowing what others are doing or whether they are working at all. Oftentimes ‘silence’ of a team member is interpreted as a sign that the other person is not working, whereas this person on the contrary might be experiencing problems with her tasks and therefore take longer to respond (Cramton, 2001). In a nutshell, activity awareness can help individuals to align their work with others as well as reduce misunderstandings.

H2: Activity awareness increases coordination quality.

3.4 Satisfaction

We define satisfaction as the degree to which team members are content with the group decision and the final task solution of the team (Bui and Sivasankaran, 1990). In a literature review about virtual teams, Powell (2004) identifies team information sharing and team coordination as important task processes leading to higher performance and satisfaction in teams. Individuals will be more satisfied if there are few misunderstandings and the team manages work in a well-coordinated fashion (Cramton, 2001).

H3: Coordination quality increases satisfaction.

4 Method

The two SNP-prototypes were tested in an experimental research setting with 108 students attending a lecture on knowledge management systems. The students were randomly assigned to 36 triads of which one half used a platform with basic collaboration functionality and the other half used a platform with basic collaboration functionality and additional awareness support. In each platform, students had to watch a video that would explain the course of the group work and give an introduction to the functions of the specific platform. Both platform and video could only be seen by the students assigned to the specific treatment. It was made clear to the students that they were participating in an experiment but that the authors were not part of the lecturing team and thus would not grade their efforts. The organization of the group work was carried out by an independent lecturer who was blind to the hypotheses of this study. Moreover, the students were allowed to meet physically, but they were encouraged to use the platform. At the end of the group work we conducted a survey. In total 86 participants (ca. 80% respondent rate) answered the questionnaire: 38 from the basic platform and 48 from the advanced platform.

The task given to the student teams was to solve a teaching case about knowledge management in an organization. The students had five weeks for accomplishing two assignments: proposing a design for a knowledge management system in that particular organization and an action plan for fostering usage of the proposed system. Consequently, the assignment allowed for multiple correct solutions and multiple solution paths. Thus, the task was a fuzzy task characterized by high information diversity, information load, conflict and uncertainty (Campbell, 1988).

As both treatment groups were participating in the same lecture at the same time, the study setting bears potential for Hawthorne effects which could have biased our measurements. However, the hypotheses were not known to the participants and it was made clear that the questionnaires were administered by an independent researcher, not part of the lecturing team. Thus, there was no incentive for any treatment group to adapt its usage or questionnaire response behavior.

4.1 Data Analysis and Results

Both platforms were extensively used. In total 266 forum posts and 269 direct messages were sent in the basic platform and 83 forum posts, 454 direct messages and 98 feed messages (22 status updates, 14 comments and 54 team file comments) were sent in the advanced platform.

We tested our hypotheses using Partial least squares (PLS), a component-based statistical technique for causal modeling. PLS has relatively small sample size requirements and is well suited for testing structural models involving mediation (Chin, 1998). As both these issues play a role in this study, we deemed PLS as the most suitable for analyzing our model. The PLS analysis was conducted on the individual level using the 86 questionnaire responses.

4.2 Measurement Model

For evaluating the measurement model, we computed convergent and discriminant validity. As summarized in Appendix A, convergent validity was assessed through reliability of the items (all except one loading are above 0.707, but all are above 0.6), composite reliability (greater than 0.8 for all constructs) and average variance extracted (AVE) (all constructs exceed 0.5). Discriminant validity was assessed in Table 2. The correlation between the constructs are smaller than the square root of the AVE, indicating that the constructs are distinct and that they can be conceived of separate entities (Fornell and Larcker, 1981).

No.	**Construct**	**1**	**2**	**3**	**4**	**5**
1	Platform	**1***				
2	Activity Awareness	0.313	**0.925***			
3	Coordination	0.173	0.377	**0.798***		
4	Satisfaction	0.316	0.348	0.612	**0.808***	
5	Offline Activity	0.016	-0.174	0.107	0.074	**0.886***

*Table 2. Discriminant Validity (*square root of the average variance extracted (AVE))*

4.3 Structural Model

Figure 3 illustrates the model tested in PLS, including the platform manipulation as a binary variable (0: standard platform, 1: advanced platform). Next to the hypothesized relationships H1, H2 and H3, we also tested the direct paths D1 and D2 for assessing mediation. Moreover, since the students could meet physically, we controlled for offline activity (paths C1, C2 and C3). A bootstrap routine with 1000 iterations was used for estimating the significance of the path coefficients. The results in the model are presented in Table 2. We find that all hypothesized relationships of our model (H1, H2 and H3) are supported and that offline activity does have a significant influence neither on activity awareness in the platform, nor on coordination or satisfaction.

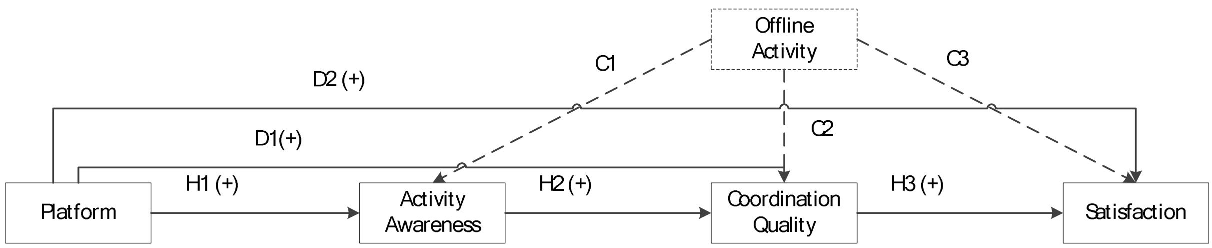

Figure 3. Hypothesized relationships (H1, H2, H3), direct paths (D1, D2) to be tested for assessing mediation, and control paths for offline activity (C1,C2,C3)

We assess mediation by checking whether a significant relation between the independent and the dependent variables is no longer significant if the mediator is incorporated into the model (Baron and Kenny, 1986). Thus, we first computed the model without the mediator activity awareness and found a significant path between platform and coordination. Second we calculated the model with the mediator activity awareness as presented in Table 2 and found that the path between platform and coordination (D1) was no longer significant. However, for the path from platform to satisfaction the path remained significant (D2), which already indicates that the mediation effect is rather low in this case.

For assessing the strength of mediation we calculated the variance accounted for (VAF) according to Shrout and Bolger (2002) by dividing the indirect by the total effect. The variance accounted for the mediator activity awareness (indirect link from platform to coordination) is thus 72.51% indicating high mediation, whereas the variance accounted for the indirect link from platform to satisfaction is only 31.21%; indicating low mediation.

Structural Relation	**Direct Effect (path coeff.)**	**T-Value**	**Indirect Effect**	**Total Effect**	R^2
H1: Platform → Activity Awareness	0.316***	3.279	-	0.316	0.130
H2: Activity Awareness → Coordination	0.393***	4.680	-	0.393	0.175
H3: Coordination → Satisfaction	0.574***	7.115	-	0.574	0.421
D1: Platform → Coordination	0.047^{ns}	0.438	0.124	0.171	
D2: Platform → Satisfaction	0.216**	2.536	0.098	0.314	
C2: Offline Activity → Activity Awareness	-0.178^{ns}	1.420	-0.001	-0.179	
C3: Offline Activity → Coordination	0.175^{ns}	1.305	-	0.175	
C4: Offline Activity → Satisfaction	0.009^{ns}	0.092	0.060	0.069	

*Table 3. Results (n=86; ^{ns}nonsignificant, ** $p < 0.05$, *** $p < 0.01$)*

5 Discussion and Implications

5.1 Discussion of Findings

The data analysis supports two major findings: the beneficial influence of the feed functions on individuals' perception of coordination as well as satisfaction; and that this effect is mediated by activity awareness. Thus, the feed functionality of the advanced platform indeed enhances perceived activity awareness of users. In particular perceived activity awareness largely mediates the influence of the platform on coordination. The mediating effect for the link between the platform and satisfaction is less strong. It is therefore most likely that satisfaction is not only influenced by coordination but also by other team processes such as consensus building, relationship building or knowledge sharing, which we did not incorporate into our model (Powell et al., 2004).

5.2 Implications

5.2.1 Theoretical Implications

Many innovations have come from redesigning and testing technologies in other contexts. In a similar vein, we redesigned a series of social media functions normally used in large communities (e.g. Facebook) for use in virtual teams. Specifically, our study contributes to the knowledge about the design and impact of awareness-enhancing social media functions by extending the model of Zigurs and Buckland (1998) with the specific aspect of awareness. While a design that meets the requirements of information processing, communication and process support – as suggested by Zigurs and Buckland (1998) – implicitly addresses activity awareness, we argue that an even better fit between the virtual teamwork and its tool support is achieved if the requirement to support activity awareness is explicitly considered. We therefore introduce activity awareness and respective awareness functions as a fourth design parameter. In particular, we theorize that awareness functions such as feeds can be used to enhance the intentional as well as the consequential communication of awareness.

Through a five-week experiment with teams working on a fuzzy task we show that the advanced platform that explicitly enhances activity awareness allows teams to better coordinate themselves and hence to be more satisfied with the results of their team work. It is also notable, that unlike with feeds in community platforms we do not find evidence for increased information overload in our team-based setting.

5.2.2 Practical Implications

We contribute to the practical knowledge about the design of social media tools in collaboration settings. Social media are more and more used in work organizations and many organizations are sceptical whether these new technologies will be used for the good of the organization. Organizations increasingly rely on the collaboration of virtual teams. We show a way how social media can be designed to help these teams to function in a better way. As the ability of virtual teams to communicate through rich communication channels, such as video-conferencing, is limited and synchronous communication is not desired at all times of the collaboration process, it is important to exploit the potential for enhancing asynchronous communication in the time between meetings. Thus, our study guides the design of asynchronous technologies that are particularly suited to bridge the silent periods between phases of synchronous communication in which many misunderstandings and uncoordinated actions can significantly lower team performance.

6 Conclusion and Outlook

In this study we constructed two collaboration platforms on the basis of social media functions. The design was driven by theory and evaluated in a field experiment. However, it should be kept in mind that our platform design was specifically directed towards supporting a fuzzy team task. Moreover, the evaluation framework was confined to only one important aspect of collaboration, namely activity awareness and its impact on coordination and satisfaction. We believe that the model could be extended by other types of awareness such as cognitive and affective awareness (Shen and Khalifa, 2009) as well as influences on other team processes such as consensus building and information sharing (Powell et al., 2004). Also this study did not explicitly address the potential downsides of awareness such as information overload, which could encounter especially in larger teams. Another limiting aspect of this study is that besides the descriptive data provided, usage is treated as a black box. This box could be opened to see how users appropriated to the different tool constellations and what the effects on team work are.

Appendix A

Construct Indicators	**Factor Loading**	**Composite Reliability**	**Cronbach's Alpha**	**AVE**
Activity Awareness		0.922	0.834	0.856
In the platform, I always knew on which tasks my team members were working.	0.941			
In the platform, I have the feeling that the other team members are aware on what I am working.	0.910			
Coordination (Adopted from Lewis, 2003)		0.838	0.724	0.637

Our team worked together in a well-coordinated fashion.	0.892			
Our team had very few misunderstandings about what to do.	0.641			
We accomplished the task smoothly and efficiently.	0.839			
Satisfaction (Adapted from Bui and Sivasankaran, 1990)		0.883	0.835	0.654
I am not satisfied with the decision making process that my group underwent to develop solutions. (reversed)	0.829			
I like the solution which my group devised.	0.752			
I am satisfied with the number of arguments that my team devised for this group work.	0.762			
I am satisfied with the work of my group.	0.885			
Offline Activity (Adapted from Ma and Agarwal, 2007)		0.916	0.868	0.785
I often communicated with my team members outside of the platform (e.g. via phone, email, personal meetings)	0.959			
Our team met multiple times.	0.839			
I often had offline contact with my team members.	0.858			

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